# 44th MEETING OF THE LNF SCIENTIFIC COMMITTEE
# FINDINGS AND RECOMMENDATIONS

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The program of the open session of the SC meeting of June 4 was set up to review the status of DAΦNE and of its experimental program, as well as the status of SPARC_LAB and of a number of other initiatives at LNF: NAUTILUS, Space research at the SCF_Lab and the activities of the theory group. Examining the extramural activities of the Labs, the status and plans of the PANDA experiment was reviewed. In the closed session of June 5, Cabibbo Laboratory director R. Petronzio gave a report on the status of the SuperB project. The future of DAΦNE and the interactions between SuperB and the programs of LNF was the main focus of large part of the closed session.

This was the first meeting chaired by Gigi Rolandi. The former chair, Matteo Cavalli-Sforza participated in this meeting and was warmly thanked for his excellent services made in the committee in the last six years.

## 1. INTERACTIONS WITH THE MANAGEMENT OF INFN

The president of INFN, F. Ferroni attended the first part of the closed session. He reminded the committee of the mandate: to report on physics issues related to the activities of the Laboratory giving unbiased suggestions. These suggestions will be brought to the attention of the managements of LNF and of INFN. The findings and recommendations of this committee are distributed to the INFN board of Directors.

He reminded the SC that in the next few months INFN has to take important decisions related to LNF:

- **DAΦNE** is not working well and is not delivering useful luminosity to any experiment. We must understand what are its limitations and its potentialities: in the most optimistic scheme **DAΦNE** can deliver good luminosity to KLOE-2, in a less optimistic scheme it can still deliver luminosity to SIDDHARTA or it can be used to validate design aspects for SuperB, like the crab-waist with the magnetic field on.

- The TDR of SuperB is being prepared. The Ministry of Research has appointed a special committee, to validate the costs of SuperB. The LNF SC should review the schedule of SuperB, assessing if this schedule is reasonable and if it is competitive with respect to the other HEP projects. Possibly producing a document before the next meeting of the committee scheduled in November 2012. In the TDR there will be the option where the 7 GeV injector of SuperB can be used for an XFEL. This latter project is less risky in terms of money and manpower.

- INFN has to understand how other activities, like ALICE, ATLAS, CMS, LHCb want to evolve in the future. Experiments that want to build part of the upgrades at LNF will be facilitated in term of resources since this will bring LNF to an excellence center.

## 2. SUPERB

Roberto Petronzio presented the status of the SuperB project. The Cabibbo lab has started to operate at the end of last year and a number of new positions have been opened. Presently underway is a detailed costing review of the project, an exercise that relies heavily on the expertise of the LNF staff. The TDR will be finalized by

middle 2013 while the time schedule and the personnel list will be available in few months. The MoU with external institutions address the issue of finding educated manpower for executing the project: some 150 people will be needed (about 50% from Italy) and it is expected that the project will rely a lot – especially at the beginning – on the expertise of LNF.

There is ample room for collaboration between LNF and Cabibbo lab, two realities at few kilometres distance working on similar projects. There are synergies and opportunities. This is already recognized by the fact that the LNF director is ex-officio member the Cabibbo lab management. However it is important that this collaboration is regulated by a formal document that clearly defines the reporting lines and the process for setting the priorities in the use of the resources.

The SC was informed of a very interesting option of an XFEL based on the SuperB injector linac. This option stands to greatly enlarge the scientific footprint of the SuperB in the Italian and international scientific community. Additional cost and demands placed on such a linear accelerator by the challenging requirements of an extremely high luminosity collider and high peak brightness XFEL have to be evaluated in detail.

The SC is worried that the SuperB project is attracting resources from LNF while the Laboratory is lacking resources on high priority project like DAΦNE and on the technical services (see section 3).

### 2.1 Recommendations

*The SC recommends that LNF and Cabibbo Lab regulate their collaboration on a short time scale with a document that clearly defines the process for setting the priorities in the use of the resources and the reporting lines.*

*The SC recommends that the staff of the LNF, reinforced by the additional resources that may come from the SuperB project, should be fully devoted to pursuing of the DAΦNE programme on the short time scale.*

## 3. DAΦNE, KLOE and SIDDHARTA

This section summarizes the findings about DAΦNE and its experiments including the discussion in the closed session with a common recommendation at the end of the section.

### 3.1 DAΦNE

The luminosity level in KLOE2 has reached the best level achieved in the past (best in a day was 7 $pb^{-1}$), but with higher specific luminosity. The increased specific luminosity holds promise for meeting the KLOE physics requirements. The detector background levels were tolerable at the present level of beam currents. However low availability levels have plagued DAΦNE operation in 2012, most of

the time at 50% and only occasionally reaching the 80% level assumed in the estimates so far.

Realistically - with present knowledge - one could expect an integrated luminosity per year of running to be of the order of 1.5 – 2 $fb^{-1}$, provided that DAΦNE reaches stable operation.

L. Rivkin, L. Rolandi and S. Stapnes met members of the Accelerator Division to discuss **DAΦNE** status and expected future developments of the **DAΦNE** operation.

Electron beam current is limited by the transverse blow-up; positron beam current by the electron cloud effect, requiring replacement of the voltage generators. There is a low threshold for the microwave instability and further work is needed to identify and remove the cause of these limitations.

The large number of interruptions of machine operation makes this diagnostic very difficult. DAΦNE accelerator team has formulated a comprehensive consolidation programme, as well as a minimum set of measures required to be implemented on the very short time scale.

Immediate needs include replacement of lost personnel, at least five physicists and engineers, as well as a number of technicians. Minimum investments of around 250 kEuros now and additional 300 kEuros by the shutdown in October are needed.

Technical division personnel needs are also an important limitation to smooth operation of the accelerator (e.g. the need to replace a cooling system specialist who is leaving is but an illustration of the degree and nature of problems that LNF faces in trying to run all of its projects). The SC has been informed that the consolidation needs involve a number of positions in both Technical and Accelerator divisions.

### 3.2 KLOE

By May 2012 KLOE has collected about 400 $pb^{-1}$. It is however not clear if all these data are usable for physics due to background conditions.

In view of the degraded performance of DAΦNE, KLOE-2 presented a best adopted physics program under the assumption that 5 - 10 $fb^{-1}$ may become available for physics analysis within next 2-3 years. Despite the reduced data sample their program remains viable and covers diverse areas of physics exploiting the new detectors that will be installed soon. This program includes

- Improved accuracy on $f_+(0)\times V_{us}$ by a factor 2 providing an improved test of the CKM unitarity.
- Improved sensitivity by a factor 4 of the tests of Quantum Mechanics coherence and CPT-invariance done with Kaon interferometry.

- New measurement in low energy hadronic physics
- New measurements in gamma-gamma physics including the light-by-light term contributing to the muon magnetic anomaly

During the SC meeting A. Golutvin, M. Cavalli-Sforza and G. Colangelo met members of the Collaboration to discuss the status of the upgrades and the physics program.

The KLOE-2 collaboration is fully committed to the installation of the new subdetectors, the Inner Tracker (IT), scintillating tile-tungsten calorimeter (QCALT) and very forward crystal (LYSO) calorimeter, in fall of 2012.
The construction of all sub-detectors is progressing well. KLOE-2 presented a detailed installation plan, which requires about 6 months.

### 3.3 SIDDHARTA

The first phase of the experiment is concluded: the measurement of kaonic 1s level shift and width in hydrogen, by now published in PLB (2011) and NPA (2012) is a remarkable achievement in Kaon Nuclear Physics for years to come.

Observing the kaonic 1s level in deuterium by SIDDHARTA-2 would constitute a comparable achievement. The physics case of SIDDHARTA-2, is fully supported by the theoretical community. It could be done also in JParc, but only on the long time scale.

During the SC meeting A. Gal and Y. Karyotakis met with representatives of the Collaboration to discuss their estimates of yield, backgrounds and instrumentation for measuring kaonic deuterium. The SIDDHARTA spokespersons expressed a strong anxiety about uncertainties on definite schedule for running the experiment. They could be ready any time from the beginning of 2013 and on, perhaps even as soon as this coming Fall.

### 3.4 Discussion about DAΦNE in the closed session

The LNF director presented several requests to INFN for extra funding targeted to DAΦNE maintenance. Due to the overall situation these requests have not been accepted. A. Zoccoli says that INFN received the requests and that will give support even if the overall situation is bad due to cuts in the budget. LNF can help in solving cash-flow problems. Money is needed to put DAΦNE in stable conditions; in addition it is important to inject fresh manpower needed to consolidate the services and to work on the improvement of the luminosity. The focus must be on consolidation more than on fixing the problems as they come.

The SC could advice on the distribution of the manpower, but this can be done only if the laboratory clarifies the priorities and the actual distribution of resources. The director mentioned the possibility of a restructuring the services also related to the start of the Cabibbo Lab. This however will happen on the medium time scale.

### 3.5 Recommendations

*The physics case for running DAΦNE is strong:*

- *KLOE-2 , even with 5 $fb^{-1}$ of integrated luminosity, has a rich physics program with components in flavor physics, hadronic physics and tests of quantum mechanics. It requires higher level of luminosity of what presently achieved, which is in the reach.*
- *SIDDHARTA-2 has a promising physics program starting with the measurement of the kaonic 1s level in deuterium, which can be done at the present level of luminosity.*

*The missing ingredient for making a realistic schedule of the machine operations is an assessment of the achievable level of luminosity per day. The first mandatory step in this direction is to restore the smooth running of the accelerator with a consolidation program. The second step is to augment the team working on DAΦNE operations to identify and possibly remove the limitations to luminosity and background levels.*

*The SC recommends that LNF put as first priority of the Laboratory the physics program of DAΦNE, allocating resources to the consolidation of the machine and to the technical divisions with the primary goals of reaching a) smooth operation of the accelerator and b) an assessment of the achievable level of luminosity. This should be done also using resources presently allocated to other programs.*

*The SC recommends that the LNF management produce a resource-loaded schedule to achieve these goals. Once they are achieved the schedule of the machine will be discussed including the running of the two experiments.*

## 4. SPARC_Lab

During the past six months there has been progress on many fronts:

- Installation of the electron beam line for the Terahertz radiation source achieving emittance of ~1.5 mm mrad (300 pC, 90% of charge) meeting the design values for the Thomson scattering experiment.
- Progress on the installation of the optical 30 fs synchronization system.
- Successful high-power test of a short C-band accelerating structure.
- Installation and characterization of the photon beam line from the FLAME laser to the Thomson interaction region.

During the SC meeting, J. Rossbach , M. Carpinelli and F. Cervelli met with Enrica Chiadroni, Leonida Gizzi, Giampiero Di Pirro and Cristina Vaccarezza to discuss a number of scientific, technical and management issues related to SPARC_LAB. The findings are as follows:

While the electron beam line for the Terahertz radiation source is perfectly adequate for commissioning of the Thomson scattering experiment, there is still

some room for improvement. In this context it is highly acknowledged that the construction of a novel photo-injector gun has been initiated.

The initiative on the optical synchronization system should be supported and continued since synchronization down to the few fs level will be essential for many SPARC_LAB experiments. In particular, a position for a key person coordinating work on RF and synchronization should be secured. Contacts to and collaboration with other labs exist and should be intensified.

The project team working on the C-band accelerating structure may wish to think about intensifying the collaboration with other labs working on C-band structures, such as PSI.

The progress of the Flame laser is rather slow due to lack of manpower. In a wider context it can be concluded that LNF needs to establish a real laser group.

The hardware inventory of SPARC_LAB is up-to-date but it is acting in a very competitive field. Proper support by LNF is needed to keep the momentum of this activity otherwise the investment made will become unattractive soon. While the present scientific program is diversified, making full use of the existing hardware, an overall strategy and the definition of priorities is missing. The installation of the Program Advisory Board (PAB) is an important step to achieve this important goal.

During the discussion, a number of high-priority experiments were identified: Thomson scattering, plasma acceleration based on an external electron injection and electron beam driven plasma acceleration based on the comb beam technology. The latter one is a good example of an experiment where LNF has a chance to be the first and the only one.

SPARC_LAB urgently needs a time schedule. This information is indispensable when attracting external users. A Technical Design Report is under way and should be published by the end of 2012. SPARC_LAB is perfectly suited for establishing collaborations with external user groups, if its basic infrastructure and team are adequately supported by LNF. Further means of attracting such groups should be worked out, e.g. an informative website and presentations at conferences.

SPARC_LAB and LNF represent a unique opportunity to attract young students: a PhD course must be established defining a strong education program in collaboration with one or more university faculties.

### 4.1 Recommendations

*The SC invites the SPARC_LAB team to formulate a master plan describing the road map of how to achieve the goal of few fs synchronization of optical synchronization system.*

*With help of the Program Advisory Board, LNF management should develop its own visions about an overall strategy and the definition of priorities for SPARC_LAB. Including the priorities in the allocation of resources.*

*The team working of Thompson scattering should define more clearly what will be delivered and when. In view of the mammography application a goal should be expressed quantitatively.*

*SPARC_LAB management should prepare a time schedule for at least the next two years indicating also slots for potential external users and a plan of available resources. An informative WEB site to attract external users should be prepared.*

*A PhD course in collaboration with nearby universities should be established.*

## 5. NAUTILUS

The contribution of Resonant Bars like NAUTILUS has been essential in establishing the field of the search for gravitational waves, giving interesting results and putting some important upper limits. Nautilus is running with 95% duty cycle to monitor possible strong gravitational waves sources in the Galaxy. The data are validated by cosmic ray acoustic effects.

Today the hope for detection of gravitational waves is in the Network of long arm interferometers. However VIRGO and LIGO are now in upgrading their detectors and will be inactive till about middle of 2014. For this reason the Collaboration proposes to run NAUTILUS and AURIGA in continuous and coordinated operation, with the goal of searching for strong galactic sources during the period not covered by long arm interferometers.

### 5.1 Recommendations

*The SC recommends guaranteeing the run of NAUTILUS until VIRGO will restart after its upgrade, in spite of the limited sensitivity of the NAUTILUS detector compared to the interferometers.*

## 6. Theory Group

The Theory Group of LNF consists of 7 staff members, active in various fields. After the presentation made in the open session by the local coordinator focused mainly on a few research lines (i.e. strongly correlated electron systems and nanostructures, extended supergravity and black holes), A. Lerda and G. Colangelo met with the coordinator and with other members of the group who attended the session.

There is a large portion of the group working at a very high level on phenomenological topics of high-energy physics and also in relation with the

experimental groups. Including the past activity related to the KLOE experiment, and the more recent ones related to the LHC experiments, regarding issues of physics beyond the Standard Model, flavor physics, Higgs production, search of massive Z' gauge bosons and so on. It is interesting to point out also the collaboration with the ALICE experiment for the development of a Monte Carlo algorithm for heavy ion collisions to study the phenomenon of jet-quenching in the Quark Gluon Plasma. There are also valuable on-going activities on lattice gauge theories, the study of phase transitions and critical phenomena in fundamental processes, and on astroparticle physics and processes of the early universe. All these activities are carried out at international level, and the members of the Theory Group have a high reputation inside the theoretical community, as the impact of their scientific production demonstrates.

The LNF Theory Group organizes valid activities like the Spring School or other thematic workshops.

It is a striking feature that a group of 7 tenured researchers is involved in 5 different lines of research. Given this fact it is therefore difficult to consider it as a "group". In a National Laboratory of the size as LNF a more focused theoretical activity should be preferred since a theory group of a laboratory should aim at becoming a reference point for the experimental colleagues and also help them and the management to devise and shape the general strategy of the Laboratory. In its present configuration the theory group of LNF is certainly lacking this feature. This is not meant as a criticism to the current members, but it is a fact that reflects the historical difficulty in conceiving and implementing a strategy for the development of the theory group of LNF.

The composition of the Theory Group as far as the research associates are concerned (also for the part of the Gruppo Collegato di Cosenza), looks somehow unbalanced with respect to the mainstream activities of LNF.

The members of the group complain about the lack of young people (students, post-docs, visitors ...) who are extremely important to create a productive atmosphere and stimulate group activities.

### 6.1 Recommendations

*The SC recommends defining a clear strategy for the Theory Group of LNF. A working group with representatives from the Theory Group, the Lab management and theorists from nearby universities should be formed with the mandate to define and state this strategy for the medium/long term.*

*An effort should be made to increase the number of young people in the group: establishing collaborations/official agreements with nearby universities and possibly finding ways to finance more postdoc positions.*

## 7. Space Research at the SCF_LAB

The **S**atellite/Lunar/GNSS laser ranging **C**haracterization **F**acility **LAB**oratory operates in clean room at LNF two unique and unprecedented Optical Ground Support Equipments to characterize the space segments for these programs. They simulate in laboratory the conditions in space and they deliver the integrated thermal behavior and optical response of Laser Retroreflector Arrays (LRAs) in that environment. The group is involved in the analysis of the data providing important tests of General Relativity. Large part of the funding of the SCF_LAB is from external agencies.

### 7.1 Recommendations

*The SC takes note that the group is making good use of existing infrastructures (eg. clean rooms) giving added value to the Laboratory also with external contracts.*

## 8. PANDA

The PANDA experiment at FAIR (GSI) has a schedule with start of data-taking in 2018. Many INFN groups participate to PANDA and have central responsibilities in the Collaboration: LNF is involved in the Straw Tube Tracker (SST) and P. Gianotti is deputy-spokesperson and coordinator of the tracking system. However the INFN participation to PANDA has not been formalized yet. The PANDA collaboration has recently decided that the SST - proposed by the LNF group- will serve as solution for the central tracker. This is a very light design with only 1.2% of radiation length. Construction is foreseen to start in 2013 and LNF has the responsibility for the straw construction, the mechanics, and the detector integration.

### 8.1 Recommendations

*The SC acknowledges the good work done on the SST and is impressed by the very light design. The SC recommends that the participation of INFN to PANDA and to its funding is clarified before the start of the construction at LNF and takes note that Commissione Nazionale III has a new scientific committee to better understand the scientific position of PANDA.*